# WATER QUALITY MEMORANDUM

Utah Coal Regulatory Program

January 15, 2008

TO: Internal File

THRU: Pamela Grubaugh-Littig, Permit Supervisor

FROM: Dana Dean, P.E., Senior Reclamation Hydrologist

RE: 2006 Second Quarter Water Monitoring, Genwal Resources, Inc., Crandall Canyon Mine, C/015/0032-WQ06-2 Task #2662

The Crandall Canyon Mine was conducting continuous miner retreat mining in barrier pillars along the mains during the second quarter of 2007. Water monitoring requirements can be found in Section 7.31.21, and 7.31.22 of the MRP, especially Tables 7-4, 7-5, 7-8, 7-9, and 7-10.

**1. Was data submitted for all of the MRP required sites?** YES ☒ NO ☐

***Springs***

*The MRP requires the Permittee to monitor 24 springs each quarter. Some require full laboratory analysis according to Table 7-4, while others simply require field measurements.*

The Permittee submitted all required samples for the spring sites.

***Streams***

*The MRP requires the Permittee to monitor12 streams each quarter. Some require full laboratory analysis according to Table 7-8, while others simply require field measurements.*

The Permittee submitted all required samples for the stream sites.

***Wells***

*The MRP requires the Permittee to monitor 7 wells during the second quarter. All require full laboratory analysis according to Table 7-4.*

The Permittee submitted all required samples for the wells. Two were dry, and five were in-mine wells located in now inaccessible areas of the mine.

***UPDES***

*The UPDES Permit/MRP require monthly monitoring of 2 outfalls: 001,sed. pond discharge, and 002, mine water discharge.*

The Permittee submitted all required samples for the UPDES sites. Outfall 001 reported no flow.

**2. Were all required parameters reported for each site?** YES ☒ NO ☐

**3. Were any irregularities found in the data?** YES ☒ NO ☐

Some parameters fell outside of two standard deviations from the mean encountered at the respective sites. They were:

| Site | Parameter | Value | Standard Deviations from Mean | Mean |
|---|---|---|---|---|
| SP1-19 | Flow | 105 gpm | 2.12 | 20.91 gpm |
| SP2-9 | Flow | 8.22 gpm | 2.34 | 2.33 gpm |
| SP2-9 | Total Alkalinity | 130 mg/L | 2.16 | 148.34 mg/L |
| SP-36 | Dissolved Magnesium | 53.1 mg/L | 2.26 | 46.97 mg/L |
| SP-58 | Total Hardness | 460 mg/L | 2.49 | 311.72 mg/L |
| SP-58 | Total Dissolved Solids | 514 mg/L | 2.38 | 335.68 mg/L |
| SP-58 | Sulfate | 144 mg/L | 2.04 | 54.09 mg/L |

Dissolved magnesium has a weak upward trend at SP-36 ($R^2 = 0.4827$). There is a very narrow range, from 41 mg/L to 53 mg/L. Such a small fluctuation does not affect the water quality.

The flows at SP1-19 and SP2-9 follow the Palmer Hydrologic Drought and Surface Water Supply Indexes fairly closely. In addition, the Permittee's hydrologic consultant stated "If you look at the historic data for SP1-19, it is typical for that spring to have really big flows in June, and then the flows rapidly wane later in the season. I think it is a fracture controlled system that has a quick groundwater travel velocity relative to the storage volume. The spring always starts out with a bang then dies out quickly as the storage is depleted. I think that because of the rapid travel velocity the magnitude of the flow measurement may also be a function of exactly when in the quarter the spring was monitored relative to when the peak of the snowmelt for the season occurred."

There is a weak upward trend in sulfate at SP-58 ($R^2 = 0.4707$). Sulfate is not toxic to plants or animals (even at very high concentration), but has a cathartic effect on humans in concentrations over 500 mg/L. For this reason, the EPA has set the secondary standard as 250 mg/L. The sulfate at SP-58 has always been less than 200 mg/L, except for 1 reading of 200 mg/L in 1989.

There is no trend in the alkalinity at SP2-9, and the range is very tight (37 mg/L). Alkalinity is a measure of buffering capacity, or the ability of a water-source to absorb acid without a change in pH, this narrow fluctuation should cause no practical changes in buffering capacity.

There is a fairly strong upward trend in total dissolved solids at SP-58 ($R^2 = 0.6333$), but it has always been below the secondary drinking water standard of 500 mg/L, and this quarter it is just above that level. The Division will closely monitor the trend of this parameter at SP-58.

The total hardness at SP-58 has a fairly strong upward trend ($R^2 = 0.6682$). The concentrations have always fallen into the hard (150-300 mg/L – 38 of 70 samples) or very hard ranges (>300 mg/l –32 of 70 samples).

Many routine reliability checks fell outside of standard values:

| Site | Reliability Check | Value Should Be... | Value is... |
|---|---|---|---|
| BCF | TDS/Conductivity | >0.55 & <0.75 | 0.53 |
| BCF | Conductivity/Cations | >90 & < 110 | 85 |
| BCF | K/(Na + K) | < 20% | 54% |
| BCF | Mg/(Ca + Mg) | < 40 % | 51% |
| BCF | Na/(Na + Cl) | > 50% | 24% |
| Horse Canyon Creek | Conductivity/Cations | >90 & < 110 | 84 |
| Horse Canyon Creek | K/(Na + K) | < 20% | 43% |
| Horse Canyon Creek | Mg/(Ca + Mg) | < 40 % | 50% |
| Horse Canyon Creek | Na/(Na + Cl) | > 50% | 26% |
| IBC-1 | Conductivity/Cations | >90 & < 110 | 78 |
| IBC-1 | K/(Na + K) | < 20% | 41% |
| IBC-1 | Mg/(Ca + Mg) | < 40 % | 55% |
| IBC-1 | Na/(Na + Cl) | > 50% | 26% |
| Indian Creek | Conductivity/Cations | >90 & < 110 | 83 |
| Indian Creek | K/(Na + K) | < 20% | 27% |
| Indian Creek | Na/(Na + Cl) | > 50% | 41% |
| Little Bear Creek | Conductivity/Cations | >90 & < 110 | 83 |
| Little Bear Creek | K/(Na + K) | < 20% | 44% |

| | | | |
|---|---|---|---|
| Little Bear Creek | Mg/(Ca + Mg) | < 40 % | 56% |
| Little Bear Creek | Na/(Na + Cl) | > 50% | 24% |
| LOF-1 | Conductivity/Cations | >90 & < 110 | 79 |
| LOF-1 | K/(Na + K) | < 20% | 38% |
| LOF-1 | Mg/(Ca + Mg) | < 40 % | 45% |
| LOF-1 | Na/(Na + Cl) | > 50% | 38% |
| Section 4 Creek | Conductivity/Cations | >90 & < 110 | 80 |
| Section 4 Creek | K/(Na + K) | < 20% | 46% |
| Section 4 Creek | Mg/(Ca + Mg) | < 40 % | 62% |
| Section 4 Creek | Na/(Na + Cl) | > 50% | 22% |
| Section 5 Creek | Conductivity/Cations | >90 & < 110 | 80 |
| Section 5 Creek | K/(Na + K) | < 20% | 38% |
| Section 5 Creek | Mg/(Ca + Mg) | < 40 % | 61% |
| Section 5 Creek | Na/(Na + Cl) | > 50% | 24% |
| UPF-1 | Conductivity/Cations | >90 & < 110 | 79 |
| UPF-1 | K/(Na + K) | < 20% | 43% |
| UPF-1 | Mg/(Ca + Mg) | < 40 % | 41% |
| UPF-1 | Na/(Na + Cl) | > 50% | 38% |
| LB5-A | Conductivity/Cations | >90 & < 110 | 80 |
| LB5-A | K/(Na + K) | < 20% | 41% |
| LB5-A | Mg/(Ca + Mg) | < 40 % | 50% |
| LB5-A | Na/(Na + Cl) | > 50% | 24% |
| Little Bear Spring | TDS/Conductivity | >0.55 & <0.75 | 0.53 |
| Little Bear Spring | Conductivity/Cations | >90 & < 110 | 83 |
| Little Bear Spring | K/(Na + K) | < 20% | 41% |
| Little Bear Spring | Mg/(Ca + Mg) | < 40 % | 47% |
| Little Bear Spring | Na/(Na + Cl) | > 50% | 32% |
| SP1-33 | Conductivity/Cations | >90 & < 110 | 82 |
| SP1-33 | K/(Na + K) | < 20% | 42% |
| SP1-33 | Na/(Na + Cl) | > 50% | 29% |
| SP1-9 | K/(Na + K) | < 20% | 60% |
| SP1-9 | Na/(Na + Cl) | > 50% | 21% |
| SP2-24 | Cation/Anion Balance | < 5% | 9.09% |
| SP2-24 | K/(Na + K) | < 20% | 95% |
| SP2-24 | Na/(Na + Cl) | > 50% | 7% |
| SP2-9 | K/(Na + K) | < 20% | 65% |
| SP2-9 | Na/(Na + Cl) | > 50% | 15% |
| SP-36 | Conductivity/Cations | >90 & < 110 | 84 |
| SP-36 | K/(Na + K) | < 20% | 34% |
| SP-36 | Mg/(Ca + Mg) | < 40 % | 56% |
| SP-36 | Na/(Na + Cl) | > 50% | 20% |

| | | | |
|---|---|---|---|
| SP-58 | Conductivity/Cations | >90 & < 110 | 77 |
| SP-58 | K/(Na + K) | < 20% | 55% |
| SP-58 | Mg/(Ca + Mg) | < 40 % | 44% |
| SP-58 | Na/(Na + Cl) | > 50% | 25% |
| SP-79 | Conductivity/Cations | >90 & < 110 | 78 |
| SP-79 | K/(Na + K) | < 20% | 53% |
| SP-79 | Mg/(Ca + Mg) | < 40 % | 63% |
| SP-79 | Ca/(Ca + $SO_4$) | >50% | 49% |
| SP-79 | Na/(Na + Cl) | > 50% | 23% |

These inconsistencies do not necessarily mean that a sample is wrong, but it does indicate that something is unusual. An analysis and explanation of the inconsistencies by the Permittee would help to increase the Division's confidence in the samples. The Permittee should work with the lab to make sure that samples pass all quality checks so that the reliability of the samples does not come into question. The Permittee can learn more about these reliability checks and some of the geological and other factors that could influence them by reading Chapter 4 of *Water Quality Data: Analysis and Interpretation* by Arthur W. Hounslow.

**4. On what date does the MRP require a five-year re-sampling of baseline water data.**

Page 7-33 of the MRP states that groundwater samples collected during the low flow period every 5 years will be analyzed for baseline parameters.

Page 7-35 of the MRP states that surface water samples collected during the low flow period every 5 years will be analyzed for baseline parameters.

Therefore, the next re-sampling of baseline parameters is required by the fourth quarter of 2010.

**5. Based on your review, what further actions, if any, do you recommend?**

No further actions are necessary at this time.

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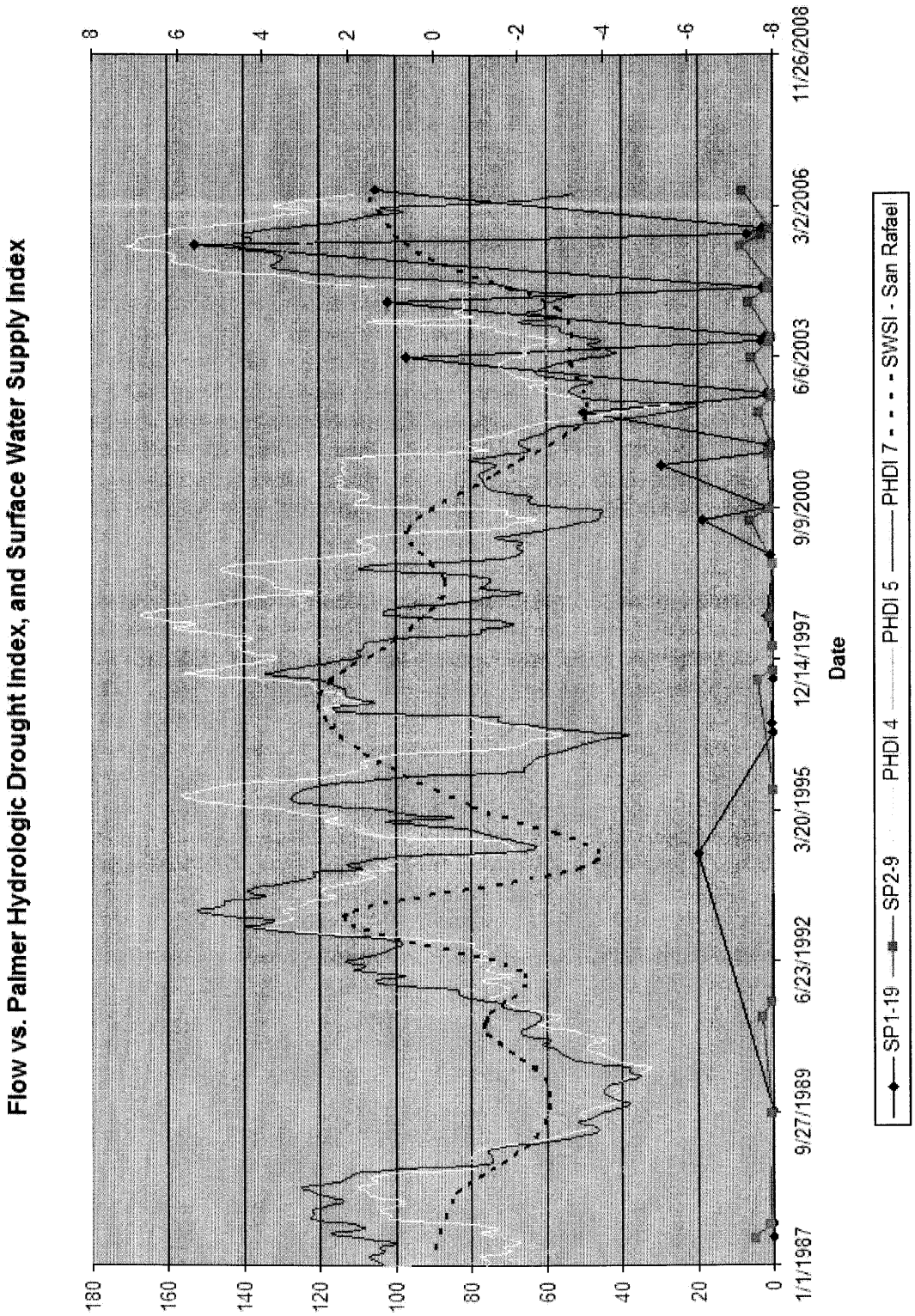
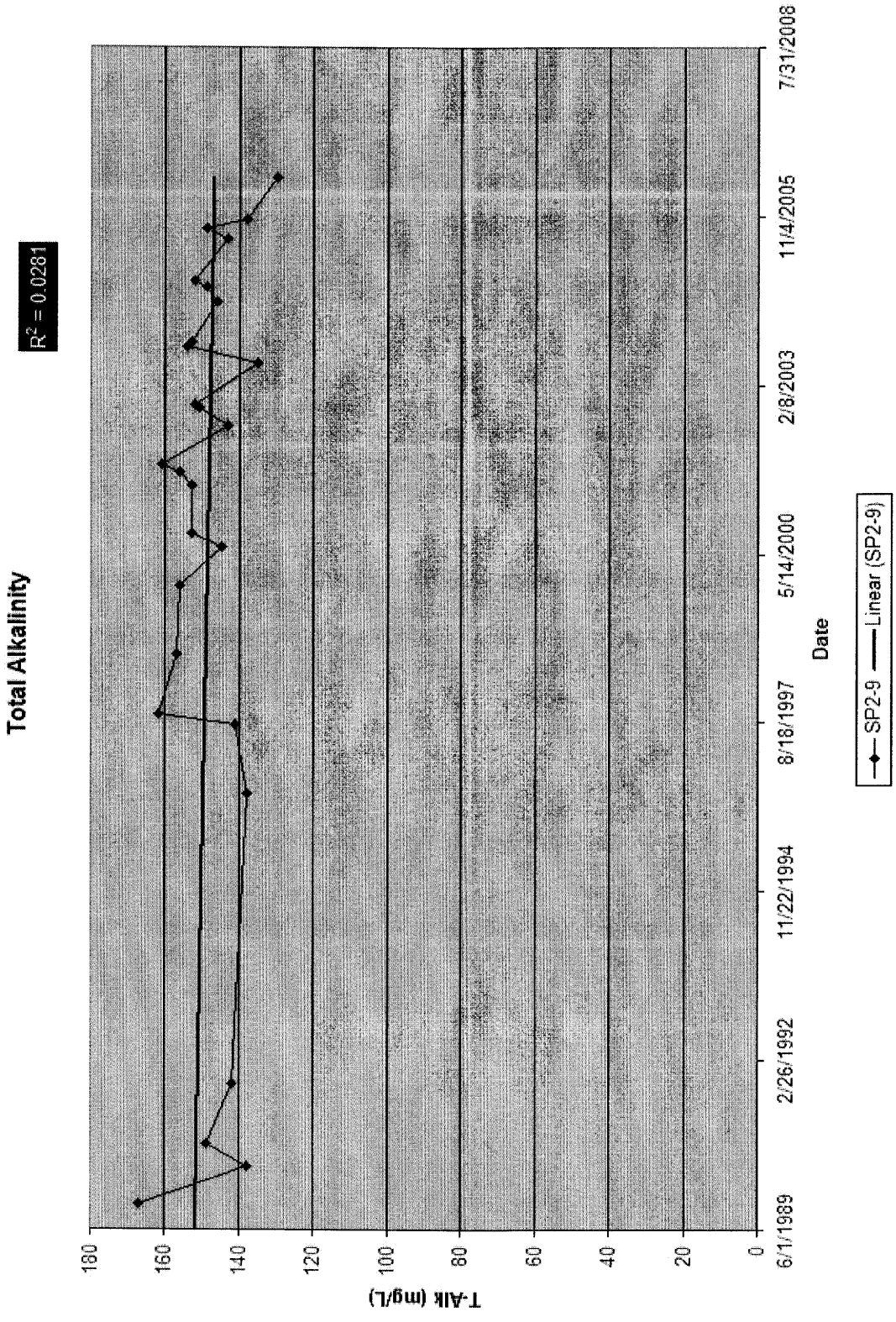
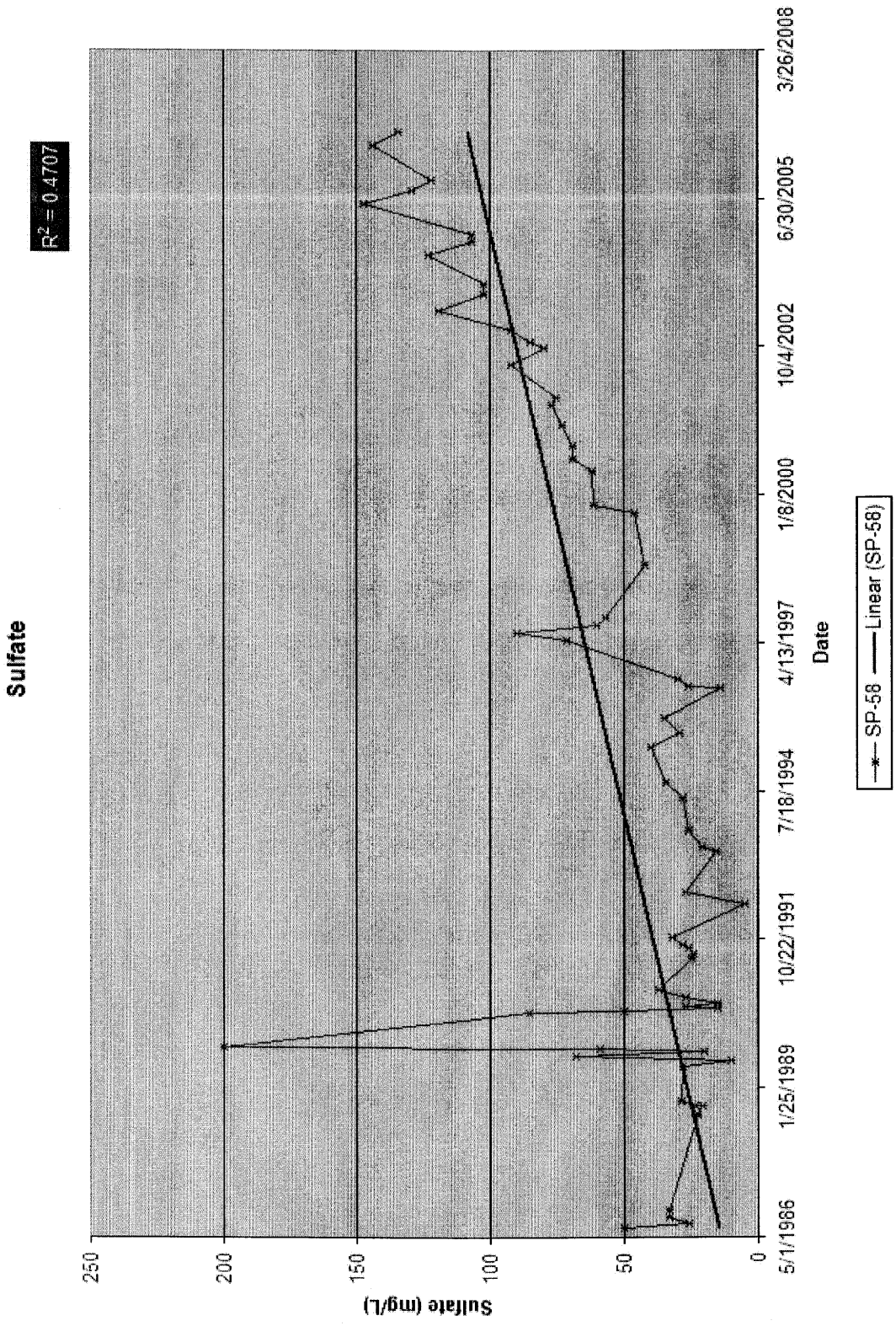
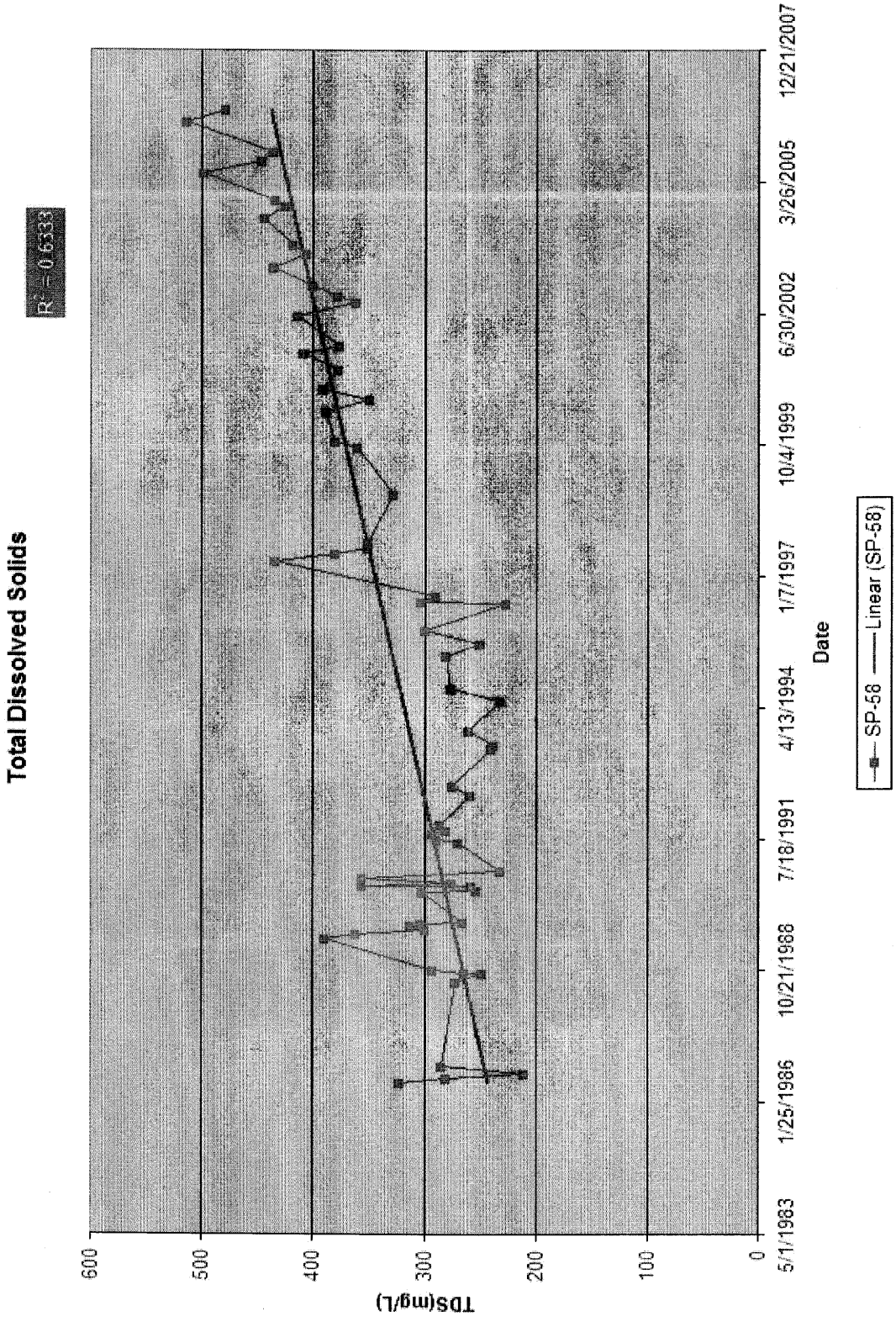
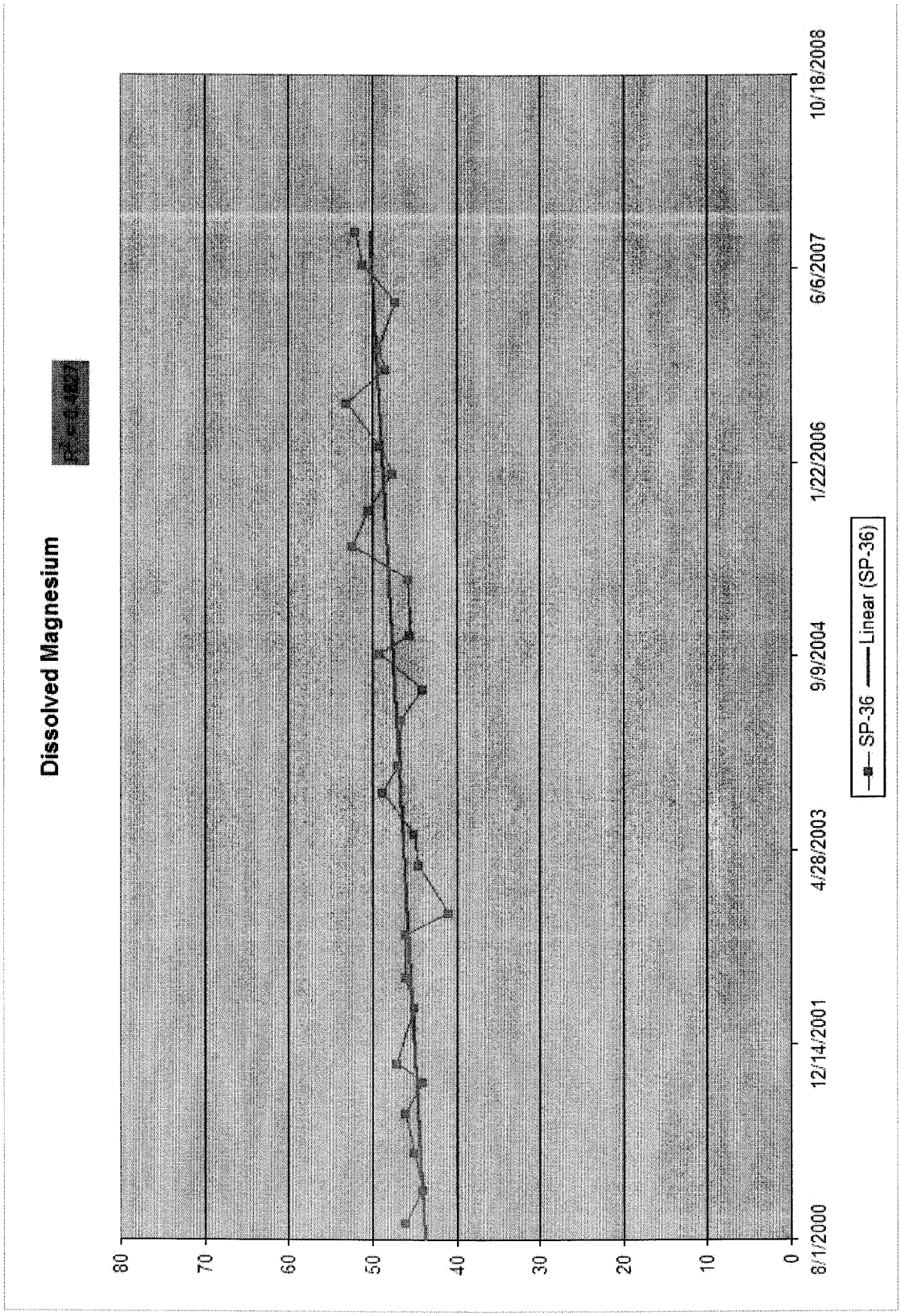
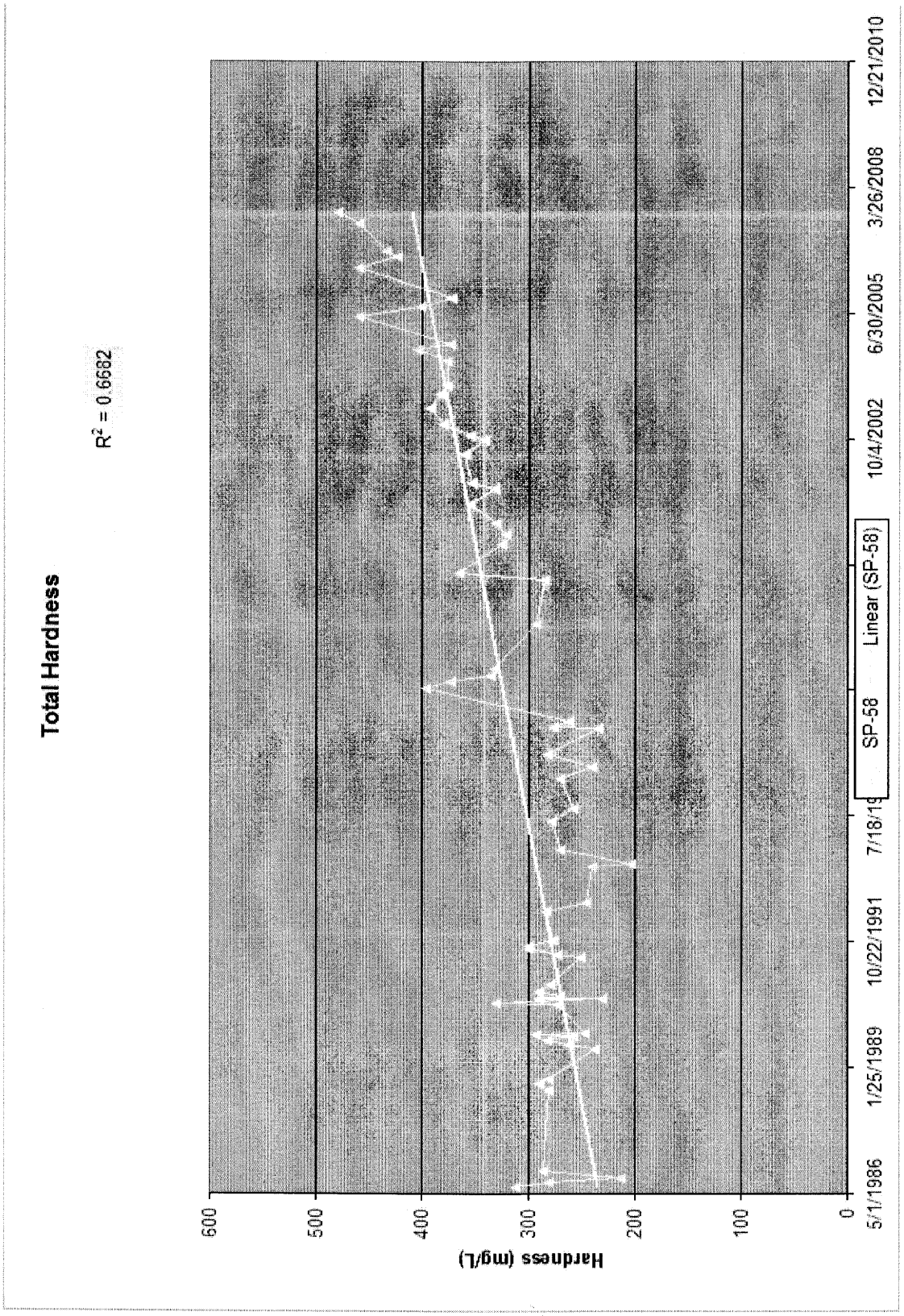

Flow vs. Palmer Hydrologic Drought Index, and Surface Water Supply Index
Flow (gpm)
180
160
140
120
100
80
60
40
20
0
8
6
4
2
0
-2
-4
-6
-8
1/1/1987
9/27/1989
6/23/1992
3/20/1995
12/14/1997
9/9/2000
6/6/2003
3/2/2006
11/26/2008
Date
SP1-19
SP2-9
PHDI 4
PHDI 5
PHDI 7
SWSI - San Rafael


Total Alkalinity
$R^2$ = 0.0281
T-Alk (mg/L)
180
160
140
120
100
80
60
40
20
0
6/1/1989
2/26/1992
11/22/1994
8/18/1997
5/14/2000
2/8/2003
11/4/2005
7/31/2008
Date
SP2-9
Linear (SP2-9)


Sulfate
R² = 0.4707
Sulfate (mg/L)
250
200
150
100
50
0
5/1/1986
1/25/1989
10/22/1991
7/18/1994
4/13/1997
1/8/2000
10/4/2002
6/30/2005
3/26/2008
Date
SP-58
Linear (SP-58)


Total Dissolved Solids
R² = 0.6333
TDS(mg/L)
600
500
400
300
200
100
0
5/1/1983
1/25/1986
10/21/1988
7/18/1991
4/13/1994
1/7/1997
10/4/1999
6/30/2002
3/26/2005
12/21/2007
Date
SP-58
Linear (SP-58)


Dissolved Magnesium
R² = 0.4827
80
70
60
50
40
30
20
10
0
8/1/2000
12/14/2001
4/28/2003
9/9/2004
1/22/2006
6/6/2007
10/18/2008
SP-36
Linear (SP-36)


Total Hardness
$R^2$ = 0.6682
Hardness (mg/L)
600
500
400
300
200
100
0
5/1/1986
1/25/1989
10/22/1991
7/18/19
10/4/2002
6/30/2005
3/26/2008
12/21/2010
SP-58
Linear (SP-58)